CLAIMS

1. A process for improving a material hardness and an elastic modulus of an organosilicate film, the process comprising:

depositing the organosilicate film onto at least a portion of a substrate via chemical vapor deposition of an at least one chemical reagent comprising a structure-former precursor to provide the organosilicate film having a first material hardness and a first elastic modulus; and

exposing the organosilicate film to an ultraviolet radiation source within a non-oxidizing atmosphere to provide the organosilicate film having a second material hardness and a second elastic modulus wherein the second material hardness and the second elastic modulus are at least 10% higher than the first material hardness and the first elastic modulus.

2. The process of claim 1 further comprising treating the organosilicate film with at least one energy source.

3. The process of claim 2 wherein the treating step occurs during at least a portion of the exposing step.

4. The process of claim 2 wherein the at least one energy source heats the organosilicate film to a temperature between 25 to 450°C.

5. The process of claim 1 wherein the temperature of the organosilicate film during the depositing step ranges from 25 to 450°C.

6. The process of claim 5 wherein the temperature of the organosilicate film during the depositing step ranges from 250 to 450°C.

7. The process of claim 1 wherein the depositing step involves one or more processes selected from the group consisting of thermal chemical vapor deposition, plasma enhanced chemical vapor deposition, cryogenic chemical vapor deposition, chemical assisted vapor deposition, hot-filament chemical vapor deposition, photo-initiated chemical vapor deposition, and combinations thereof.

8. The process of claim 7 wherein the forming step is plasma enhanced chemical vapor deposition.

9. The process of claim 1 wherein the ultraviolet light has one or more wavelengths of about 400 nm or below.

10. The process of claim 1 wherein the ultraviolet light has one or more wavelengths of about 300 nm or below.

11. The process of claim 1 wherein the ultraviolet light has one or more wavelengths of about 200 nm or below.

12. The process of claim 1 wherein the non-oxidizing atmosphere contains at least one gas selected from the group consisting of nitrogen, hydrogen, carbon monoxide, carbon dioxide, helium, argon, neon, krypton, xenon, radon, and combinations thereof.

13. The process of claim 1 wherein the non-oxidizing atmosphere comprises a vacuum.

14. The process of claim 13 wherein the pressure ranges from 0.005 millitorr to 5000 torr.

15. The process of claim 1 wherein the at least one chemical reagent further comprises a pore-former precursor.

16. The process of claim 15 wherein the dielectric constant of the organosilicate film after the exposing step is at least 5% less than the dielectric constant of the organosilicate film before the exposing step.

17. The organosilicate film prepared by the process of claim 1.

18. The organosilicate film of claim 17 having a compositional non-uniformity of about 10% or less.

19. A method for improving a material hardness and an elastic modulus of a porous organosilicate film deposited by chemical vapor deposition represented by the formula $Si_vO_wC_xH_yF_z$, where $v+w+x+y+z = 100\%$, v is from 10 to 35 atomic%, w is from 10 to 65 atomic%, x is from 5 to 30 atomic%, y is from 10 to 50 atomic%, and z is from 0 to 15 atomic%, the method comprising:

providing a substrate within a vacuum chamber;

introducing at least one chemical reagent comprising a structure-former precursor selected from the group consisting of an organosilane and an organosiloxane and a pore-former precursor into the vacuum chamber;

applying energy to the at least one chemical reagent in the vacuum chamber to induce reaction of the reagent to deposit a composite film comprised of a pore-former material and a structure-former material on at least a portion of the substrate; and

exposing the composite film to an ultraviolet light source within a non-oxidizing atmosphere to provide a porous organosilicate film wherein the material

hardness and the elastic modulus of the porous organosilicate film after the exposing step are higher than the material hardness and the elastic modulus of the the composite film before the exposing step and wherein the porous organosilicate film is substantially free of Si-OH bonds.

20. The method of claim 19 further comprising heating the porous organosilicate film wherein the heating step is conducted prior to the exposing step.

21. The method of claim 19 wherein the organosilane is at least one member from the group consisting of methylsilane, dimethylsilane, trimethylsilane, tetramethylsilane, phenylsilane, methylphenylsilane, cyclohexylsilane, tert-butylsilane, ethylsilane, diethylsilane, tetraethoxysilane, dimethyldiethoxysilane, dimethyldimethoxysilane, dimethylethoxysilane, methyldiethoxysilane, triethoxysilane, methyltriethoxysilane, trimethylphenoxysilane, phenoxysilane, ditertbutylsilane, diethoxysilane, diacetoxymethylsilane, methyltriethoxysilane, di-tert-butylsilane and combinations thereof.

22. The method of claim 19 wherein the organosiloxane is at least one member from the group consisting of 1,3,5,7-tetramethylcyclotetrasiloxane, octamethylcyclotetrasiloxane, hexamethylcyclotrisiloxane, hexamethyldisiloxane, 1,1,2,2-tetramethyldisiloxane, octamethyltrisiloxane, and combinations thereof.

23. The method of claim 19 wherein the pore-former precursor is at least one member from the group consisting of alpha-terpinene, limonene, cyclohexane, 1,2,4-trimethylcyclohexane, 1,5-dimethyl-1,5-cyclooctadiene, camphene, adamantane, 1,3-butadiene, substituted dienes, gamma-terpinene, alpha-pinene, beta-pinene, decahydronaphthelene, and combinations thereof.

24. The method of claim 19 wherein the pore-former precursor and the structure-former precursor are the same compound.

25. The method of claim 24 wherein the compound is at least one member from the group consisting of 1-neohexyl-1,3,5,7-tetramethyl-cyclotetrasiloxane, di-neohexyl-diethoxysilane, 1,4-bis(diethoxysilyl)cylcohexane, and combinations thereof.

26. The method of claim 19 wherein the substrate is heated during at least a portion of the exposing step.

27. The method of claim 19 wherein the applying step is conducted at a temperature of about 250°C or greater.

28. The organosilicate film prepared by the method of claim 19.

29. The organosilicate film of claim 28 having a compositional non-uniformity of about 10% or less.

30. A mixture for depositing an organosilicate film comprising a dielectric constant of 3.5 or below, the mixture comprising at least one structure-former precursor selected from the group consisting of an organosilane and an organosiloxane and a pore-former precursor wherein at least one precursor and/or the organosilicate film exhibits an absorbance in the 200 to 400 nm wavelength range.

31. A mixture for depositing an organosilicate film, the mixture comprising: from 5 to 95% by weight of a structure-former precursor selected from the group consisting of an organosilane and an organosiloxane and from 5 to 95% by weight of a pore-former precursor wherein at least one of the precursors and/or the organosilicate film exhibits an absorbance in the 200 to 400 nm wavelength range.

32. A process for preparing a porous organosilicate film having a dielectric constant of 2.7 or less, the process comprising:

forming a composite film comprising a structure-former material and a pore-former material onto at least a portion of a substrate wherein the organosilicate film has a first dielectric constant, a first hardness, and a first elastic modulus; and

exposing the film to at least one ultraviolet light source within a non-oxidizing atmosphere to remove at least a portion of the pore-former material contained therein and provide the porous organosilicate film wherein the porous organosilicate film has a second dielectric constant, a second hardness, and a second elastic modulus and wherein the second dielectric constant is at least 5% less than the first dielectric constant, the second hardness is at least 10% greater than the first hardness, and the second elastic modulus is at least 10% greater than the first material modulus; and

heating the organosilicate film wherein the heating step is conducted prior to the exposing step.

33. The process of claim 32 wherein the forming step is conducted at a temperature of about 250°C or greater.

34. The process of claim 32 wherein the organosilicate film is represented by the formula $Si_vO_wC_xH_yF_z$, where v+w+x+y+z = 100%, v is from 10 to 35 atomic%, w is from 10 to 65 atomic%, x is from 5 to 30 atomic%, y is from 10 to 50 atomic%, and z is from 0 to 15 atomic%.
35. The process of claim 32 wherein the organosilicate film has one or more bond types selected from the group consisting of silicon-carbon bonds, silicon-oxygen bonds, silicon-hydrogen bonds, and carbon-hydrogen bonds.
36. The process of claim 32 wherein the organosilicate film has a compositional non-uniformity of about 10% or less.
37. An organosilicate film prepared by the process of claim 32.

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